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Senate Commerce, Science and Transportation Subcommittee on Science, Technology and Space Holds Hearing on the Future of NASA

BROWNBACK:

The hearing will come to order. Thank you all for joining us today. I think we will be joined by some other members. A little bit later on, there's a briefing going on right by Secretary Rumsfeld that a number of people have gone over to. And I certainly don't blame them. I was tempted myself to postpone the hearing for an hour's period of time, but finding an hour during the day is just tough to find. So I decided to go ahead and go forward with the hearing, but I would anticipate we'll probably be joined by some other members here a little bit later on.

America's consistently proven her leadership in space science technology. The predominance of America in space came from the charge set forth by President Kennedy, that landed man on the moon and returned him safely on earth -- to earth.

The technological advances made during the Apollo era were a result of the U.S. space program pushing forward and human space exploration. Today, I hope to take a look back briefly at the recent history of human space exploration, specifically the space shuttle, as well as a look forward at what the vision of NASA should be.

This is going to be one of a number of hearings that I anticipate that we'll do in this subcommittee, looking at the future of NASA, moving towards a reauthorization bill for NASA that hasn't been done for now some 10 years. And these hearings, I hope to mold all together into an effective effort to move forward reauthorization bill for NASA.

Recently, the shuttle has been a topic of many discussions and debates in the wake of the Columbia shuttle disaster. As these debates continue, I hope we'll be able to add to that discussion today.

In the wake of the Columbia tragedy and the decision to not replace Columbia, I must take a close look at our efforts in developing the next launch vehicle for NASA. It is imperative that we make our way to space and do so as quickly and as safely as possible. As tempting as it is to accelerate the process at developing our next launch vehicle, we must do so as safely as we possibly can.

I cannot say right now whether more money is the answer to the problems NASA has encountered in their quest for a new launch vehicle. However, I fully intend to look at the budget of NASA and determine where they are hurting, where they are operating successfully, and whether they are involved with projects that could be better accomplished by another agency or by the private sector. I certainly hope that today we can bring to light some of the issues behind the future of human space flight and help determine where NASA needs to go.

When President Kennedy challenged America to send a man to the moon and return him safely to earth by the end of the decade, NASA was sent on a mission in which the only option for the outcome was success. It seems that it is going to take that same kind of dedication and determination to successfully accomplish the next step in human space exploration.

The future of the space program is also contingent upon a role that private businesses play in the process. As the government looks at ways to save costs, NASA will have to rely more heavily on private investment and commitments. Spurring competition within the private sector could reduce the pressure on NASA to accomplish everything in space.

For example, Transorbital, a California company is working on the first commercial project to the moon for the Trailblazer. And that is exactly what this country needs right now, someone or something to blaze the trails between the earth and the stars and human exploration.

Currently NASA and Russia are the only countries successfully launching humans into space. However, we are continually hearing comments by the Chinese in reports that as early as October, they too will be launching its first astronaut into space.

If China does become the third space faring nation, we are faced with more complicated and urgent matter here in America. Today I hope to learn more about how NASA came to the decision using the shuttle, and if the shuttle is the best means of space transportation for the future.

Additionally, I'd like our witnesses to comment on the role of human space exploration in the overall goals of NASA. Just a few weeks ago, members of NASA's advisory council announced their concerns that NASA's decision to build an orbital space plane lacks vision. I hope that today we can help determine what a vision for human space flight in the U.S. should look like and bring focus where we are currently lacking.

In the days immediately following the Columbia tragedy, I stated that we needed to take a step back and take a close look at where NASA has been, where they are currently, and where they needed to go in the future.

That's exactly what we will be discussing today. Marcia Smith with the Congressional Research Service will talk with us about the fundamental question of how did we get here. That is, how did we get -- the U.S. get - how did the U.S. get to the current point of using the space shuttle as our means of transportation to and from space? I welcome to the committee and her years of expertise in studying this issue.

Mr. Brian Chase with the National Space Society will discuss access to space and human space flight initiatives related to new space transportation systems. As Mr. Chase will lay out access to space as the most critical part of any space exploration effort, something that the founders of this organization, Dr. Vanbraun, would agree with that.

And finally, we will hear from Dr. Alex Roland, a former NASA historian and current professor at Duke University. Dr. Roland will discuss flaws of the current space program and present his recommendations on how NASA should proceed with space exploration. We look forward to hearing from all of our witnesses in this first hearing.

Before we go there, I'd like to turn to my colleague from Louisiana, where I guess Katie will be going, but Duke Clone (ph), I don't mean to rub it in, Dr. Roland, but the New Orleans here on Saturday that we're excited about. We normally lose to Duke, but we finally got over this time.

BREAUX:

Sure. Well, we welcome you to New Orleans and the team and wish you the very best. It's going to be a great event. Thank you for having this hearing. I think it's timely. I think it's important. Hopefully, it'll be very informative. I think this country is indeed at the crossroads of where are we going to be in the future with regard to exploration of space.

There are many who will look at the space shuttle and this recent disaster as a reason to call for the termination of space exploration. I think that that is not a correct conclusion. And I think that we obviously need to find out what went wrong. I think NASA and the independent board is -- are looking at that. We'll find out what happened and take the necessary steps to correct it.

We will explore space because it is there and because we learn a lot from those efforts. And we develop technology because of those efforts, which benefit all of us in ways that we could only dream of a couple of generations ago.

So I do think that it's important to have this opportunity to assess where we are, where are we going to be, what needs to be done, because I have no doubt that all the workers and the thousands of employees and contractors that are all part of what we call space exploration will continue to do a remarkable job. And I look forward the witnesses' testimony.

BROWNBACK:

Thank you Senator Breaux.

First, will be Miss Marcia Smith, specialist in Aerospace technology policy from the Congressional Research Service. Welcome.

SMITH:

Mr. Chairman, Senator Breaux, thank you for inviting me here today. to discuss the history of the human space flight program in the context of the space shuttle Columbia accident. I ask that my written statement be made part of the record.

BROWNBACK:

Without objection.

SMITH:

You asked that I address the fundamental question of how did we get here? The answer has two components. Why does the United

States have a human space flight program? And why did we decide to build the space shuttle?

BROWNBACK:

Miss Smith, pull that microphone up a little closer to you, if you would. Thanks.

SMITH:

The dream of people journeying into space has been the lore of science fiction for centuries. By the time Sputnik 1 ushered in the space age in 1957, a cadre of enthusiasts was ready to make such dreams a reality. Congress passed the National Aeronautics and Space Act in 1958, creating NASA and establishing as one objective the preservation of the role of the United States as a leader in space science and technology.

In 1959, NASA selected the first group of astronauts, the Mercury 7. Two years later, the first human orbited the earth, but it was not one of the Mercury 7. Instead, it was a Soviet cosmonaut, Juri Gagarin.

Gagarin's flight added new impetus to the U.S. program. America's leadership in space science and technology, its international prestige, and many believed its national security were at stake.

Three weeks later, Alan Shepard became the first American in space, but it was a suborbital flight. The United States did not match Gagarin's speed until 10 months later when John Glenn became the first American in orbit.

The risks were high in those early flights. Yet the nation was willing to accept those risks and pay the cost, to ensure American pre-eminence. Indeed, only three weeks after Alan Shepard's flight, President Kennedy called on the nation to commit itself to the goal

of landing a man on the moon by the end of the decade. And the nation said yes.

Although the space program has changed in many ways since then, human space flight as an indicator of technological pre-eminence appears to remain a strong factor in its support.

And there are other reasons. President George H.W. Bush, the first President Bush, may have articulated them best in July 1989, when on the 20th anniversary of the first Apollo lunar landing, he announced a commitment to returning humans to the moon and going on to Mars.

He said, "Why the moon? Why Mars? Because it is humanity's destiny to strive to seek to find and because it is America's destiny to lead." That is not to say that human space flight is without controversy. The debate over the need to send humans into space is as old as the space program itself. And over the past 42 years, little progress seems to have been made in bridging the divide between those who believe human space flight is essential, and those who believe it is a waste of a money, and an unnecessary risk to human life.

Since your other witnesses here this afternoon are going to debate that topic, I will not. Suffice it to say that to date, the United States and other countries have decided that human space flight is worth the cost and the risks.

Representatives of 31 countries have traveled into space over the past 42 years on American and Russian spacecraft. And later this year, China is expected to launch its own astronaut into space for the first time.

The next question is why the shuttle? As 1969 dawned and the first Apollo lunar landing neared, President Nixon took office and faced the question of what goal should guide the space program in the post Apollo years?

He established a space task group, chaired by Vice President Agnew, that developed a plan to build a space station, a reusable space transportation system to service it, and to send humans to Mars.

But after America won the moon race, support for expensive human space missions waned. NASA found that it had to pick just one of those new projects. It chose the reusable space transportation system, the space shuttle.

One goal of the shuttle program was to significantly reduce the cost of launching people and cargo into space.

The reusable space shuttle was intended to replace all other U.S. launched vehicles, so-called expendable launch vehicles that can only be used once.

By transferring all space traffic to the shuttle, NASA projected that the shuttle's development and operations costs would be amortized over a large number of launches, 48 per year, with resulting cost efficiencies.

(UNKNOWN)

How many per year?

SMITH:

48.

(UNKNOWN)

Per year?

SMITH:

Per year.

(UNKNOWN)

At one time, they said 60.

SMITH:

That premise had not held true, however. The costs were higher and the flight rate lower. Today, many point to the shuttle as a technical success, but an economic failure.

NASA has initiated several attempts to develop successors to the shuttle with the continued goal of reducing costs. Each attempt has failed in turn in large part because anticipated technological advances did not materialize.

Late last year, NASA announced that it would continue operating the shuttle, until at least 2015, and perhaps 2020 or longer. Despite the Columbia tragedy, NASA officials have made clear that plan is unchanged.

Congress is now again assessing the cost and benefits of human space flight. Based on past experience, many expect that the decision will be made to continue the human space flight program essentially unchanged once the cause of the Columbia accident is determined and fixed.

But there are a number of options to consider from returning the shuttle to flight as soon as possible, to terminating the human space flight program entirely.

I've summarized those options in my written statement, and would be happy to discuss them with you if you wish. Thank you. And I'd be happy to answer any questions that you have.

BROWNBACK:

Thanks, Ms. Smith. And I appreciate your expertise that's been available for many years to Congress to help us look at this overall issue. We will get into a lot of this in the questions and answers.

Mr. Chase, executive director of the National Space Society, welcome. The floor is yours.

CHASE:

Thank you, Mr. Chairman, Senator Breaux.

Robust, low cost access to space is the key to expanding our opportunities in space, whether in low earth orbit or beyond. And this issue is even more critical in the wake of the loss of the space shuttle Columbia.

NASA's 2004 budget submission contains important elements of an integrated space transportation plan to begin addressing this important issue.

The first element of the plan is the service life extension program, which addresses the need to upgrade the space shuttle fleet and its supporting infrastructure. The space shuttle is the only vehicle that can complete the international space station. So we need to return the fleet to service as quickly as is feasible, to let it complete that mission.

Although the original estimates for the shuttle's costs were very optimistic, as already been said, the space shuttle's capabilities remain unmatched today. But we cannot escape the need for a

backup to the shuttle. So the second element of the plan is to provide a complementary capability to transfer crews to and from the space station.

The current proposal, called the orbital space plane, would be launched aboard evolved expendable launch vehicles, EELVs, developed jointly by the Department of Defense, and industry, and now operated commercially by Boeing and Lockheed Martin at the Delta 4 and Atlas 5.

While the orbital space plane could serve as a component for a next generation launch vehicle, it serves only as a complement to, not a replacement for the shuttle during this phase.

CHASE:

The additional benefit of the orbital space plane would be its utility in future human missions, all of which will require crude transfer capabilities.

The third element of NASA's plan is the development of the next generation launch system, that would ultimately replace the space shuttle. The next general launch technology program, which is being conducted jointly with the Department of Defense, focuses on new technologies that can lead to launch systems with much greater reliability and much lower costs.

This NASA DOD partnership is the one that should be encouraged and fostered. These three elements are all an important efforts to improve our access to space. And I believe NASA's initial plan is a prudent step in that direction.

However, there are also several critical factors that could be major stumbling blocks to its success. First, the loss of Columbia dramatically underscores the urgency to develop a secondary capability to launch crews to and from the space station.

The orbital space plane can be built using today's technology. And most of the designs under consideration have been studied in several variations for the last 20 to 30 years. So there needs to be a very serious effort to accelerate this program, while keeping it focused on its core mission of launching and retrieving crews.

Second, NASA has to reexamine a backup capability to launch unmanned cargo to the international space station. NASA's alternate access to station initiative was doing just that, but that program is slated is terminated this summer without moving into the tester development phase. The author and access to station programs should get a fresh look from NASA.

Third, once the orbital space plane in some form of a backup cargo capability are activated, we should not rush to an artificial deadline to develop a new launch system. While it's important for us to continue making investments in new launch technology, it's equally important that we develop a strategic plan for our space exploration efforts, and not waste time and money jumping from program to program.

Finally, I believe the key yet overlooked element in this debate is the evolved expendable launch vehicle I mentioned earlier. Although designed initially for unmanned missions, the fleet of EELVs represent significant improvements in safety, reliability, and efficiency over their predecessors.

Once modified for human launch requirements to handle orbital space plane missions, the EELVs will represent a formidable and versatile fleet of vehicles that can fulfill an even wider range of missions than they perform today.

Importantly, by expanding the EELV's market to include crew and cargo to ISS, that improves our nation's competitiveness in the commercial space arena as well.

In summary, I believe NASA's plan to be a reasonable approach. We should be begin making the investments now, to ensure we can complete the international space station and then build a robust, yet simple secondary capability to transfer crew and cargo to and from orbit.

Beyond that, though, we should carefully consider our next steps as part of a long term space architecture, that provides a bold vision for the future.

We can certainly begin building some of that infrastructure today, but we need a roadmap to put that infrastructure to work. I thank you for the opportunity to appear today, and look forward to your questions.

BROWNBACK:

Thank you, Mr. Chase. And I look forward to a discussion as well.

Dr. Roland, Dr. Alex Roland is professor of history at Department of History, Duke University, and a former historian for NASA. Thank you for joining us today.

ROLAND:

Senator Brownback, Senator Breaux, thank you for the opportunity to share with you my views on human space flight, which will be considerably different than what you've heard so far, though there are many points of convergence.

The Columbia accident confirmed what the Challenger accident made clear, systemic flaws in the space shuttle render it unsustainable, as the safe, reliable and economical launch vehicle.

The Rogers Commission issued two critical injunctions to NASA. Do not rely on the space shuttle as the mainstay of your launch capability. Begin at once to develop a next generation launch vehicle.

16 years later, NASA is massively dependent upon the shuttle. No replacement is in sight.

I have appended my written remarks and article explaining how and why the shuttle program became systemically flawed. Briefly stated, NASA made two mistakes in shuttle development in the late '60s and early 1970s. First, it traded development costs for operational costs. Second, it convinced itself that a recoverable launch vehicle would be inherently more economical than inexpendable.

NASA promised savings of 90 -- even 95 percent in launch costs. In practice, it cost more to put a pound to payload in orbit aboard the shuttle than it did aboard the Saturn launch vehicle that preceded it.

These mistakes produced a program that cannot work. NASA could conceivably operate the shuttle safely and reliably, but it dares not admit what it would cost. The evidence for this was abundant before the Challenger accident. Instead of listening to that data, NASA consistently allowed its judgment to be clouded by its hopes and predictions for human activities in space.

The agency cares about astronaut safety, but it's trapped by its own claims about shuttle costs. And unlike expendable launch vehicles, the shuttle grows more dangerous and more expensive to fly with each passing year.

In what it euphemistically called success oriented management, that is hoping for the best, NASA assumed in 1970 that each orbiter would fly 50 times. In those heady days, NASA was expecting 60 shuttle flights a year. By 1985, meaning that a fleet of five shuttles would be completely replaced every five years, no one imagined that a shuttle would be in service after 20 years, let alone 30 or 40 years.

Unfortunately, nothing practical can be done now to save the shuttle program. A crew escape system would help reduce the risk to human life, but it cannot eliminate it. It is not clear the crew escape

could have saved the astronauts aboard either Columbia or Challenger.

Nor will an infusion of new money suffice. The United States spends more on space than the rest of the world combined. NASA has ample funding to support a robust space program. It has simply wasted too much of that money flying astronauts on unnecessary missions aboard a ruinously expensive spacecraft.

We should drastically curtail human space flight until we have a safe, reliable, and economical launch vehicle. In the meantime, anything we want to do in space, except having humans there as an end in itself, we can do more effectively and efficiently with automated spacecraft controlled from earth.

Whenever we put people in a spacecraft, we change the primary goal, be it reconnaissance or communication, science or exploration to bringing the astronauts back alive.

Most of the weight and hence the cost of manned missions comes from safety and life support systems. The astronauts contribute little. Even the astronauts aboard Columbia -- even have the astronauts aboard Columbia known of the damage to their spacecraft, they could not have saved themselves.

NASA should begin at once to carry out the recommendations of the Rogers Commission. It should limit shuttle flights to a bare minimum. It should convert the space station into a space platform to be visited, but not inhabited. And it should use the savings from these actions to fund development of a new launch vehicle.

I have enormous confidence in NASA's ability to achieve a vital and productive space program, including both human and automated missions. But to achieve that goal, it must do the right thing. That means phasing out the shuttle. It is a death trap and a budgetary sink hole. NASA must develop a stable of launch vehicles that will open up the promise of space.

I believe that we should send people into space only when they have something to do there, commensurate with the risk and cost of sending them. Given the liabilities of the shuttle, I do not know of any mission now that meets that criterion.

Thank you.

BROWNBACK:

Good statements by all. Let's run the clock at seven minutes, and then we can bounce back and forth. When -- I'll let it go a couple of rounds here.

Ms. Smith, what -- do we know what the cost per shuttle flight is now?

SMITH:

That's not an easy question to answer. It depends on how you look at it. There are two ways that those costs are usually described. One is called average costs and the other is called marginal costs.

The average cost essentially take the annual shuttle budget and divide it by however many flights there were that year. So if five flights or six flights, whatever, you just do the math. It comes out to $400, $500 million dollars a year.

BROWNBACK:

$400, $500 million dollars?

SMITH:

$400 to $500 million per flight I'm sorry.

BROWNBACK:

Per flight?

SMITH:

Yes. The marginal costs are the additive costs of flying an additional shuttle mission in a given year. Or the costs that you would save if you did not fly a particular shuttle mission.

So it doesn't account for the infrastructure cost, basically, of the shuttle program. NASA currently calculates the marginal costs of a shuttle flight at $115 million a year. And that's in full cost accounting.

BROWNBACK:

Okay. Mr. Chase, what's the vision -- what should the vision be as to why we are going to space? If you were to articulate that in a way that the American people would identify with, what would that vision be as to why we should be going to space?

CHASE:

I think the traditional reasons that have been put forward, spin-offs and the value to education and the value for international cooperation, those are all benefits, but those aren't the overall rationale for going to space. I don't think any one of those can justify the expenditures and the programs.

I think there's something much bigger at stake here. And that is if you look historically, societies that have expanded their frontiers and the ones that have prospered, the ones that had the energy and the drive within that society to do other things, whether it's economically or other areas of success within that society.

And I think that as soon as society begins or stops exploring and stops opening that frontier, you begin to risk some long term detrimental effects. That's not something you'll see in five or maybe even 10 years, but you have a long term detrimental effect that will impact society.

So I think that that's one of the motivating factors, that is a hallmark of societies that are successful and are leaders in their world. So I think that's an important reason.

Clearly, there are a lot of outstanding benefits to the motivation aspect in terms of motivating the next generation of explorers, the next generation of scientists and engineers. And frankly for that matter, the next generation of business leaders and lawyers and anyone else who may be engaged in that business or aspire to a higher calling.

So it's -- there's a lot of reasons to go. I don't think there's any single reason that is a...

BROWNBACK:

But how would you articulate it to the American people? We're talking about, you know, if we continue forward, billions of dollars annually, how would you articulate it?

CHASE:

I think you would articulate it by saying that this is important to the future of our -- not just our society, but even in some ways, our civilization to continue being a leader in the world.

And it's important for their kids to have opportunities that they see a hope for the future. You know, there's not a lot that we look at, that says here's the vision for 10 years down the road. There's something hopeful that you may be able to step foot on another planet or another planetary body, and have the chance to experience something that no human has experienced before.

To have experiences that nobody's ever had before. And that can be a very motivating factor for a child or even for someone today, who is interested in that field.

BROWNBACK:

So it's to open space for the vision of humanity, as always pressing forward?

CHASE:

It really is. There's -- there are economic reasons. There are social reasons. But it's a continuous expansion of our frontiers and of our understanding of society and then obviously the benefit through technology that accrue to this society that choose to do that.

BROWNBACK:

Dr. Roland, how would you answer that question? What's the vision for why we should be pursuing space?

ROLAND:

There are two things. I think it is important to do exploration in space, but it's my very strong belief that any exploration that you want to do in space with our current technology, you will achieve far more with automated space craft, than you will with people.

It costs -- any mission you do in space, it costs 10 times as much if you send people along. So if you want to go to Mars and explore, you can send 10 unmanned missions for the price of one manned mission. And the main purpose of the manned mission becomes simply returning to humans.

I'm not saying that's an unimportant national goal. It is inspirational and exciting, but it's kind of a feel-good space program. And right now, I don't feel very good about our space program. I think we get much more sustained payoff than we have consistently over the last 40 years from our automated spacecraft. We've spent two-thirds of our budget on manned space flight. And we're doing basically what we were doing 40 years ago.

We sent astronauts up into low earth orbit. And they float around and come back. And it's unmanned spacecraft, the communication

satellites, the application satellite, the reconnaissance satellites, the deep space probes, they are the ones that are giving us all the payoff. So I think if we want to tell the American people that the space program is good for them, that's where we should be making our investment.

(UNKNOWN)

If you based it on scientific discovery of what's taking place, you would stand by your previous comment and?

ROLAND:

Absolutely.

(UNKNOWN)

And can you quantify that?

ROLAND:

Yes, I recommend to you an exercise. I tried a short time ago to find any scientific results from shuttle or space station research that was written up in refereed scientific journals. It doesn't appear there, because it isn't important science.

ROLAND:

All the science that NASA gets published in the best journals is coming from the automated spacecraft. Now the one exception to that is there are some human physiology experiments that are written, but that's again, it's sort of a circular argument. We're going to send people in space so they can learn to survive in space in case we ever find anything for them to do in space.

(UNKNOWN)

Ms. Smith, what would your comment be about the scientific information that we're getting? Does it come more from the manned or from the unmanned launches?

SMITH:

There is scientific information that comes from both human and robotic spacecraft. I do have to agree with Dr. Roland that it is difficult to point to some breakthrough scientific discovery that can be directly traced to the presence of humans in space.

There have been many space stations, both on the American side and on the Russian side and shuttle flights and all sorts of other flights. They do gather a great deal of data about biology, which is useful if you are going to continue launching humans into space.

They also do learn things that can be applied here on earth. So there are medical advances that other scientists say have developed because of the space program. But critics of the space program argue that those advances would have been made anyway, even if you had not been launching humans into space. And they might have been made sooner if you had not devoted sums of money to the space program, and you had devoted them to earth-based research instead.

But there is scientific data that comes back from the human flights. And there's a lot of data that comes back from the robotic flights.

BROWNBACK:

Mr. Chase, your response? Then I go to Senator Breaux.

CHASE:

Well, I think the debate between humans versus robots is actually a little bit of a false argument. I think the space program is a balanced approach. You have both human exploration, and you have robotic exploration.

There's no doubt that there are destinations in our solar system that a human will probably never ever be able to set foot. And robots are going to be a critical role in that exploration.

But there's also things that robots will never be able to do with current technology or even technology in the mid to long term future that humans will have to fulfill.

There's a certain amount of interaction with the environment. The mobility, dexterity, the response time that a human possesses. A robot can be sitting on the surface of a planet and not know what's sitting behind it, unless it's turned that direction by an operator. And even then, they may not exactly what it is.

It takes a human to get down there and interact with that object or that environment, understand what's going on.

The other thing that I think puts this in perspective is I would proffer an exercise as well. I would challenge any earth-based scientist that does work in a laboratory to ask them, would you be willing to substitute a robot for the works you're doing in your laboratory?

And I daresay the answer is no, they would not be willing to do that. Because they know they can achieve more with humans in that loop, in that capacity. Today, we have the technology to replace humans to go to Antarctica with probes and robotic measuring systems. We don't do that.

We could send probes to the bottom of the ocean, but we don't do that. We send humans. So there's a reason that scientists and the scientific arena have humans in the loop per se in those discoveries.

BROWNBACK:

Senator Breaux?

BREAUX:

Thank you, Mr. Chairman. Thank the panel for their testimony.

Dr. Roland, are you saying that this particular space shuttle is defective? Or do you think that any reuseable space shuttle that is manned is not the proper approach?

I mean, is this one uniquely defective in what you think? Or do you think if we did a venture star or type of program which was a different type of reusable vehicle, that that could be okay? It could be a better way of doing it? Or do you just fundamentally think that the reuseable manned space vehicle is not the right way to go?

ROLAND:

I think this one is uniquely defective. And I think it's conceivable that the reuseable idea could still work. And I think NASA was fully justified in pursuing it. It seemed like a good idea at the time.

What we underestimated was the wear and tear on the spacecraft that required such an extensive amount of maintenance, and wears out the spacecraft faster than we thought, that the economic model doesn't work.

Also, at the time, NASA was basing all its projections on an unrealistic economic model of how many flights there would be. And those two things together make this particular reuseable not workable. And I think we just don't know if we can design and operate a robust, reuseable that'll have a lifetime that will really make it worthwhile.

It might be that there's some combination of the two, where our orbiter is reuseable, but it launches on an expendable, and that the cost balance might show up there.

I'm just encouraging them to take the experience we've gained from the shuttle, which is not trivial, and design a better launch vehicle.

BREAUX:

How much of the -- your concerns with this particular shuttle is because of the way it is launched through the -- a rocket type of launch, as opposed to like a regular airplane, which would be suborbital type of operation?

ROLAND:

Right, I think if we could build a small orbiter that could be launched from an airplane, at least theoretically, that sounds much more appealing. Of course, the whole problem is that when any launch vehicle lifts off the ground, it has to carry all the fuel it needs to get into orbit. So the enormous cost is in the first 100 feet. And then it starts going down rapidly after that.

So if we can develop another launch vehicle that'll get the orbiter up to a level where it's only a hop into space, then we have an entirely different technological model.

BREAUX:

Is your understanding that NASA at this point really doesn't have any plans to look at an alternative type of vehicle and they're not planning to use this one for the next what, almost through the year 2020, I think, is what we hear?

ROLAND:

That's what they told us in the fall. We were waiting to see what they were going to do about the shuttle fleet. And their solution was to try and prolong its life and defer, essentially development of a replacement launch vehicle.

And I think that's the great problem. I'm not opposed to the program they've designed in general or manned space flight in general. It's just that this is not the vehicle that's going to achieve our objectives for us.

BREAUX:

From your knowledge, I mean, what type of vehicle, if you are saying look, let's look at this as an option, what would that option be?

ROLAND:

I tend to think that we ought to separate cargo and people, and that we need a small orbiter to take people into and out of space. And that's the vehicle in which we invest all the safety and life support systems, and we just make it as safe as we possibly can, but make it smaller, just carry the people.

And then we have automated. And they can be either expendable or reusable launch vehicles, the heavy lift vehicles, the trucks that carry the material up there. The astronauts meet them in orbit and do their business, and then the astronauts come back safely. And then you have the vehicle that's not only a launch vehicle for the astronauts, and much safer, but it's a emergency crew return vehicle as well. And you solve two problems at once.

BREAUX:

So you're not really saying that we just shouldn't do manned space flights at all? You're just separating the vehicle that takes humans up, as opposed to a separate vehicle that perhaps would be used for heavier payloads and would not necessarily have to have the extreme human safety precautions...

ROLAND:

Right, because this is what we do with our expendable launch vehicles. This is what the Air Force does. You accept a certain amount of -- a certain probability of failure. In other words, if you get up from 95, 96, 97 percent success rate, it's economically unfeasible to try and get that any higher.

And so, you accept an occasional loss of one of those launch vehicles, but we can't do that with people. And so, we ought to

separate those two things out, have a much higher safety standard for the smaller and lighter vehicles, just to get the people up and down.

BREAUX:

Mr. Chase and Ms. Smith, can you comment on that, Mr. Chase? You were talking about how you need humans in space, but it seems like what Dr. Roland is really suggesting is that you would still have humans in space. It would just have a different vehicle for getting there. And then you have a different vehicle for the heavier payloads that would be necessarily utilized in space. You have any comments on that?

CHASE:

Yes, sir. I do -- although I don't agree with Mr. Roland's contention on the -- on some of the lack of the value of the shuttle at this present time, I think that we actually have auditors, you have agreement in terms of where this ought to go. And some of the items that I outline in my testimony are a three stage approach that NASA's planning for their future space transportation needs.

What NASA has finally realized, and the space community has realized, is that we can't take this jump in one bite, so to speak, in one step. We can't go just straight from the old system to a brand new system that is a single staged orbit and incorporates all the latest technology.

What we've realized is that we have to do an evolutionary approach. And the evolutionary approach is, we continue to use the shuttle for the duration needed to finish the space station. The next step is you do exactly what Mr. Roland mentioned, which is put a crew transfer system in place, that can take the burden off of the shuttle, to transfer a crew to and from the space station, and be used for future missions.

And then the next stage is that crew transfer system could become part of a next generation launch technology. So you have a three pronged approach to this problem.

And I...

BREAUX:

But the problem, at least in my information from NASA, is they're not thinking in that terms right now. We're talking about the whole year, 2020, using the space shuttle as both a human delivery system, as well as the cargo delivery system. And there's not a lot on the books right now, from the standpoint of looking at the next generation. It's just not even being started yet.

CHASE:

They did have a restructuring of their space launch initiative program, which was to address the next generation system. And out of that program has been restructured the orbital space plane, and what they're calling next generation launch technology, which is being done in conjunction with the Department of Defense.

Now -- and I think -- I mentioned in my oral testimony that that's an important relationship to develop. And I think it's important for this reason. The DOD has a very strong track record in developing ex vehicles and test vehicles for their eventual systems. And I think that's an important element that has been missing in some of NASA's efforts.

We try to go too quickly to an operational system or just do one ex vehicle and all the technologies thrown at that one system. And I think a multiple approach, where we test technology in a variety of ex vehicles, and have the experience from DOD in doing that, will go a long way to solving that problem.

BREAUX:

Okay. Those are good suggestions. Thank you very much, both of you.

BROWNBACK:

Let me ask you, you got some really -- some good thoughts. I want to hear -- we hear a number of different schools of thought. And there's been, I think really, a beautiful public debate that's taken place, since this last shuttle disaster about should we do more space probes? Everybody agrees we should be in space, should be doing more unmanned, more manned. Should we be going back to the moon and colonized on the moon? Should we be going to Mars and beyond?

Great debate and the sort of thing we really ought to be talking about in broad scale. And I'm delighted we're having that sort of discussion.

I would ask I guess probably Ms. Smith would be the best one to ask this first of, what is the rationale, if we were to say the people that are most supportive of this that we're -- we need to go to the moon and establish a long term presence, an exploration presence on the moon, what's the major reason for us to do that?

SMITH:

Well, there are advocates of returning humans to the moon that would say that you could use the lunar surface as a place for scientific observatories. You could put telescopes on the far side of the moon. You could mine the moon for helium 3 and bring it back to earth and use it for fusion reactors.

BROWNBACK:

I'm sorry, for what?

SMITH:

Helium 3 and use it for fusion reactors. There are others would like to put solar power satellites on the moon and beam the energy back to earth. So there are a number of concepts out there for practical utilization of the lunar surface.

And if you also wanted to commit to sending humans to Mars someday, then you might set up fuel production sites on the moon, using the lunar materials to produce the fuel that you would need to go to Mars.

So the visionaries in the space field lay out a number of scenarios as to why it is that might want to go back to the moon.

There are others, however, who feel that we've been to the moon. Been there, done that, don't need to go back again. What we really need is a commitment to go into Mars and back some of the Apollo astronauts who've have been to the moon have that point of view.

They see going out to other places in the solar system as part of this destiny to explore. And they feel that we need to move on from what we did in the 1960s, and start a new quest to send humans to Mars.

BROWNBACK:

For - what's the purpose of going to Mars?

SMITH:

Exploration to set up settlements there, again to do scientific research, to do a lot of geological research. They make the argument that Mr. Chase was making earlier that if you have humans on site, that they're much better at doing science than robots, because they're adaptable.

When you send a robotic probe to some distant destination, if you haven't programmed it with the information it needs, then it's not

going to be able to adapt to changing circumstances, whereas people can.

So those who argue in favor of sending people to Mars want the people there on site, because the feeling is that they can do better scientific exploration there. They can look at the geological sites and decide which rocks are the most important, as former Senator Schmidt did when he was on the moon on Apollo 17.

Because he was a geologist and he was trained to do that. So people see that as sort of the added value of having people there, that you can get more bang for your buck, even though the bucks are so much greater when you're including humans.

BROWNBACK:

The cost of doing a -- an unmanned mission to Mars versus a manned mission to Mars, what factor? Do we have any idea of what factor we're looking at?

SMITH:

There are a number of ranges of cost estimates for sending people to Mars. There's a gentleman who's very enthusiastic about this, Bob Zuberin (ph), who has very low cost estimates, I believe. It's in the $10 billion range. And when NASA was last asked the question back when President Bush gave his speech in 1989, they came up with a program that was about $400 billion.

The robotic probes, how expensive they are depends on how focused they are on their missions. But they're probably, you know, $100 million, something like that. It's a vast difference.

BROWNBACK:

Dr. Roland, give me your perspective on why we should or shouldn't go back to the moon or to Mars?

ROLAND:

If the moon were paved in diamonds, it'd cost more to go get them than they're worth here on Earth. It's one of the reasons we haven't gone back to the moon is we discovered there is nothing there worth going back for. It is proved that you could do some science fair and you could do some experiments, but nothing where the payoff is anywhere near the cost. And I think the same thing is true within Mars.

This notion that humans in C-2 do better research than machines I think is simply not true. And I don't know of any particular activity that a human is going to do on Mars that a machine can't do. Remember, our machines are controlled from earth. We send them out and we tell them what to do. We don't have to pre-program. We direct them around. We have the get samples.

25 years ago, NASA could have sent an automated probe to Mars to take soil samples and bring it back. We could have it down in the Air and Space Museum now. And we haven't done those automated missions that we ought to be doing.

I have no doubt that someday, humans will go to Mars. And we'll probably go back to the moon. And we'll probably colonize the moon or Mars or some other place in space, but not with the technology that we have now. What we have now is the technology that allows us to do an enormous amount of scientific exploration. And that's being cut off while we float astronauts around in near earth orbit. It's just an imbalance of our priorities.

I agree that the space program has to have some balance of priorities, but throughout NASA's history, it's been spending two-thirds of its money on manned space flight. And we get very little payoff from that.

(UNKNOWN)

Mr. Chase, I want to give you a chance to respond to any of those comments, please.

CHASE:

I think that there's another avenue of this discussion that's worth having as well. Because I think you can make the case that there are reasons to go back to the moon and go to Mars. And I also believe that we will be doing that at some point down the road.

However, I think there's another consideration, which is it may be better for NASA to build capabilities that allow us to make decisions when we're ready to make those choices. For example, low cost access of space is a critical part of whatever sort of mission you're planning, whether it's to launch a probe to do the environmental study of the earth, whether it's a military satellite, whether it's mission to the space station, whether it's a mission to the moon or to Mars.

And so low cost access to space is a major part of any sort of an element of a future space exploration.

Another good example is NASA has begun a look at nuclear propulsion and power. Project Prometheus is in the fiscal '04 budget proposal. That has the capability that is critical to both human and robotic probes. That is a capability that will allow us to go places in the solar system, we just can't go with chemical rockets.

And that's a capability that can be built for a number of applications. And then, when we decide to make a decision about where to go, we can apply those capabilities to those missions.

Now there is somewhat of a danger in establishing a single destination for the program. Obviously, that gives you the ability to rally behind that destination. And there's a lot of very attractive reasons to do that. And it's probably the direction most people think of today as saying let's go back to a single place.

But if you apply all of your resources and all of your technology behind a single destination, and you either never get that mission going and -- or it has a failure en route, you're left with nothing in the inventory for you to do next.

So that's why there's a rationale and a growing sense even at NASA by administrator O'Keefe that we need to build capabilities to do a number of missions. And then as those missions come about, assemble those capabilities into spacecraft that can achieve that mission.

(UNKNOWN)

In my discussions with the administrator and with other people that thought about the issue, and I've been trying to have meetings with people that have thought about the space program, and none of them will identify that we need to build the capacity to travel in space. And that that's what our objective should be, is we need to build the capacity that we could get to and from Mars in a relative period of time that humans could take it, and the capacity to do it.

We don't necessarily need to say right now our objective is we're going back to the moon or to Mars, but we need to be able to build the capacity. We probably test that technology and use it through the unmanned, and then build up to the capacity to where we could do it in a manned system, but that our objective isn't go to the moon or to Mars. It's to open up space for human exploration for humanity.

How do you react to that?

CHASE:

It seems to me that there is a tendency to associate our current space age with the age of Columbus. And I think it's the wrong analogy. We're in the age of Leif Erickson.

And we have managed to get to the moon, but we don't have a robust technology and a robust infrastructure which will allow us to stay there and exploit it and create a permanent presence there.

And so our effort ought to be invested in developing that capability and infrastructure not in trying to demonstrate that we can do a technological feat. I think it was very important in the context of the Cold War to send humans to the moon as a demonstration of our technological prowess.

But I don't think we have to prove anything anymore. I think we have to have a rational space program that builds up the infrastructure, that will allow us to do all of these things in space. And we're not doing it now. We're spending our money flying astronauts around and not developing the launch vehicles we need for the future.

SMITH:

Mr. Chairman, I can't resist bringing to your attention the study that was done in 1985 to '86, with which I was associated from the National Commission on Space, called "Pioneering the Space Frontier."

And the overarching theme of that report was that we should open up the solar system for science exploration and development. And the space transportation system laid out in there, which was called "The Bridge Between Worlds" was in fact a series of spacecraft that went on interlocking orbits so that you could access Mars and areas around Mars basically any time you wanted to.

So there are folks who have thought about these things for a lot of years. The problem has always been money. They're very expensive to do. And the nation has other priorities.

And what many people who are proponents of human space flight have been searching for has been that catalyzing effect that would

make it imperative for America or for planet Earth to go out there and do it again. We had that compelling reason to go to the moon. And as Dr. Roland said, it's hard to find that compelling reason to send humans to Mars because of the expense involved in it.

So I think on various bookshelves around town and around the country, you'd find a lot of studies that came out with ideas of how you could accomplish this.

One of the concerns that the commission on space was that they didn't want to do another power program, which was a dead ended program. You went there, you picked up a rock, you came home, and it was done with. They wanted to establish that infrastructure so that you go not once, but repeatedly over and over again. You had that infrastructure in place.

The problem has always been the funding for it.

(UNKNOWN)

The -- you're talking about a catalyzing event. Are we coming upon one? If the Chinese launch into space, and that some -- we've had testimony in this committee that they will shortly thereafter announce that they are going to the moon and to stay.

ROLAND:

I can remember debating with former NASA administrator Dan Golden, who was making the same argument eight years ago, I think, threatening that if we gave up our lead in human exploitation of space, the Japanese were going to move ahead of us, and that they had a manned space program.

Now the -- it is a bad way to make our national policy to think that these symbolic programs are the best way to proceed into the future. We have 40 years of experience in space now. We really know what works and doesn't work. And we don't have to put on

demonstration programs to prove we're better than other people. We just have to develop a rational program that'll achieve our goals.

My concern -- my explanation, my historical explanation for why we're in this dilemma now, I liken it to what I call the barnstorming era of space flight, we are now in the era of space flight which is analogous to barnstorming in the 1920s. We've learned how to fly, and we didn't have any idea what to do with it. So we'd go out to the picnic and take Aunt Emma out for a trip. And you know, we're just sort of showing off in space that we know how to fly. And it was in the 1930s when the airplane turned it into a commercially useful tool and a militarily useful tool that it started to develop its own technological trajectory. And we don't have such a trajectory now.

(UNKNOWN)

Would we -- Dr. Roland, if we will continue to go after the Aunt Emma picnic and watch the launch, and come back, won't we learn as we go along, and then be able to get to a point that we find, okay, here is a very good logistical military, commercial reason for us to be up and on the moon on a permanent basis?

That if we're up there knocking around and exploring, that we will find things that we hadn't thought of previous. And isn't that actually even the truth of most of human discovery is you go, not because you particularly know why you're going to -- what you're going to get, and once you get there, you find out that you've come back with, the reasoning is far different, but very important.

ROLAND:

Well, Senator, I agree completely. And we've been doing this for 40 years. And we'd found out what works, unmanned communication satellites, unmanned reconnaissance satellites, earth resources satellites, scientific probe. We have a whole repertoire of space activity that works and is of proven productivity and usefulness. It hasn't happened with people yet.

Now I'm saying -- I'm not saying that we should stop sending people, but we haven't had that catalytic event where people have demonstrated that they're indispensable to some very useful activity in space. And I think one of the reasons is that we don't have the right infrastructure.

If we could people in space for free, there would be lots of things for them to do up there, which would be worth the cost. If it costs $1 billion to put them in space, there aren't very many things there that are worth the cost. And with all due respect to Marcia, I would maintain that $1 billion is a much better estimate of what a shuttle flight costs, that really includes the total infrastructure.

And I can give you a citation on that. And that's $1 billion a flight if you don't include amortization of the development costs. And when NASA proposed the shuttle, it said it was going to be so cheap, that it was going to amortize its development costs in the first 12 years. And of course, it never did. So you should actually be putting amortization of development costs into the cost of a shuttle flight.

And if you do that, the number is $1.7 billion a flight. But I think $1 billion is a good rough figure for what's really costing. So it's a very expensive proposition to be putting people up there.

As a matter fact, the space telescope is my favorite example. It's used as an exemplar of how useful manned space flight is. Well, we could have had two or three space telescopes for the price of the program we have because we're spending all that money every time we go up to repair it. We'd be much better off having several automated space telescopes. They'd be in a more useful orbit. They'd be of a more practical design and we wouldn't be tied down to the shuttle as we are now.

(UNKNOWN)

Some observers have suggested that NASA should explore developing a replacement for the space shuttle, instead of trying to

extend the existing program and complementing it with an orbital space plane. What are the challenges to this approach and do you support going that way?

Mr. Chase?

CHASE:

I believe that the shuttle has inherent capabilities that they need to be maintained to complete the space station, first and foremost. The remaining components of the space station are in -- most of them are at the Kennedy Space Center in Florida, waiting for launch. And those can only be launched on the space shuttle.

You can argue that that -- there was a design flaw that we should've allowed those components to flown in other systems, but the bottom line is if we intend to complete the space station, we have to have the shuttle to do that.

And there are a lot of things that have been neglected. And the investments that need to be made in the shuttle infrastructure, both the vehicles themselves, and the infrastructure at the Kennedy Space Center and other NASA centers that support the shuttle. And that's been done to some degree because there's been a sense of an either/or proposition that if you're going to fund the shuttle, you can't do next generation launch investment. Or if you're going to do next generation launch investment, you have to starve the shuttle.

And that is not the case. You can do both. In fact, there are a lot of ways to integrate the shuttle program into next generation of systems and research.

For example, the shuttle can be used as a test bed for some of the new technologies that are being looked at for next generation systems. So I think you have to have a period where you're flying the shuttle, you're also flying an orbital space plane, which is kept as simple as possible to do the crew transfer.

And then, you're also doing investment in the next generation systems. The key is I believe that NASA has matured its thinking to the point that to know that we do have to have that balanced parallel approach, rather than simply embarking on a single replacement system. And then when that fails, we've not only -- not upgraded the shuttle, but we don't have a replacement system to replace it.

Going back as well to the exploration discussion, I think that there's been a maturing of the thinking that we can't have a mission simply to go there, that we have to have to build the infrastructure, and build the capability that let's us do missions long term, not just a flags and footprint type program, which is what a lot of people describe Apollo as being.

So I think we have a phased approach that involves multiple systems being brought online.

BROWNBACK:

Been joined by a person with personal experience. Mr. Nelson, Senator Nelson of Florida, it's yours to ask questions.

NELSON:

Thank you, Mr. Chairman.

Dr. Roland, I did not see you because I was looking straight at a TV camera. Were you the Dr. Roland that was on a CBS program with me?

ROLAND:

Yes, sir.

NELSON:

I guess I don't remember. Two months ago or so.

ROLAND:

Yes, something like that. That's right.

NELSON:

You made a statement, and I heard it through my ear piece, that the Rogers Commission had recommended that the space shuttle be terminated.

ROLAND:

What I -- I believe what I said, what I meant to say and what I said in my prepared testimony here was that the Rogers Commission said do not make the shuttle the mainstay of your launch capability.

In other words, they were encouraging NASA to get on, and not to stop flying, but to get on with developing a stable of launch vehicles, where you could choose the vehicle best adapted for any particular mission.

NELSON:

And that was clearly the conclusion as a result of the Challenger tragedy, 17 years ago was that instead of the space shuttle being the space transportation system, which it was thought to be, that you would use the space shuttle primarily where you needed the human in the loop, and you would use expendable rockets to put up other payloads that you did not need the human in the loop.

ROLAND:

The...

NELSON:

That was the final result.

ROLAND:

I went back and looked at the Rogers Commission report last night, in fact. And that isn't exactly what they said, because they took their charge very seriously. And it was only to advise NASA on what to do about the shuttle program. And so, they were very cautious about what this other stable of launch vehicles should be.

I am quite sure that in their press discussion surrounding the release of the report, they did say that they thought there should be another staple of launch vehicles. And I don't think they'd limited manned space flight to the shuttle. I think they were anticipating a follow on launch manned launched vehicle.

NELSON:

And 17 years later, here we are.

ROLAND:

Here we are.

NELSON:

And we don't have one.

ROLAND:

Yes, sir.

NELSON:

I would hope that we would accelerate those technologies. And I've been kind of nipping at the heels of the administration to try to get them to do that, and not to look to NASA as the sole source of the funding for developing new technologies since in fact other agencies clearly have an interest in this well.

ROLAND:

I agree completely...

NELSON:

Other agencies, I might say, that are a lot more flush with cash than is NASA.

ROLAND:

Yes, sir.

NELSON:

Well, as you look from the experience of what we learned 17 years ago, and some of the mistakes, now Mr. Chairman, you might want to reign me in because I might be getting far afield. You're talking basically about the future of manned space flight.

So I will ask questions that are directly related to that. NASA learned a number of lessons. And I would address this to each of the three. 17 years ago, NASA learned a number of lessons. And it wasn't only about cold weather stiffening rubberized gaskets, but it was also about mistakes in human communication, where communication is like water. It's real easy to flow from the top down, but it's not necessarily as easy to flow from the bottom up.

Do you think that NASA learned those lessons and practiced those learned lessons on into this experience?

ROLAND:

I think they learned them and then forgot them again. I think the Columbia accident was very similar to the Challenger accident in the sense that it was a systemic flaw within the system. It was a stressed system in which the operators were proceeding with inadequate resources for what they were trying to do They performed heroically, but they had more problems in the system than they had resources to fix. And that meant looking the other way when a lot of problems arose. And when problems arose, stick your head in the sand and hope for the best.

And that's what happened on Challenger. And that's what happened on Columbia.

NELSON:

What do you think, Ms. Smith?

SMITH:

Well, I don't mean to put you off, senator, but I think that until the Columbia accident investigation board determines exactly what went wrong, we aren't going to know the answer to that question.

NELSON:

Mr. Chase?

CHASE:

I have to agree with Marcia that we won't know the answers until the investigation's finished. I can certainly offer some preliminary assessments that I believe to be the case. I had the privilege of working at the Johnson Space Center. I've worked for a NASA contractor. I've lived in a community around Kennedy Space Center. And so, I've observed NASA from a variety of angles, both within the agency and outside.

I think the Challenger, and certainly as your experience in the agency would probably concur, the -- there were a series of severe endemic problems within the agency that resulted in the Challenger disaster.

There was a problem of suppression of information from the top, an active suppression of information. I think in Columbia to date, we have not seen that there has been an active suppression of the information. You can debate whether or not certain pieces of information were elevated properly from within management and

engineering teams, but I have not seen evidence to date that indicates that there was an active effort to squelch that discussion.

The what-ifing scenarios of what happens to a vehicle and what happens to systems goes on on every single mission. I had the opportunity to work console for three different shuttle missions. I worked for the space station program. And that's part of what you do, is you understand the details of what happens to that vehicle and what happens to those systems.

And you go to the absolute worst case scenarios, and you talk about those. It just happens that e-mail now puts that down on paper. And some of that is now transmitted. And they can be taken out of context.

So I think that's a difference in those two areas. I'm sure that we'll find the areas that need to be improved. And those improvements certainly need to be made, but I think that is a very dramatic difference between the two incidents.

NELSON:

The question of photographs. Ms. Smith, what do you think? Looks like NASA's going to be taking photographs if such an occurrence should occur in the future. What do you think about whether or not they should have taken photographs this time?

SMITH:

Well, again, senator, not to put you off, but I don't think CRS would take a position one way or the other. I think NASA has explained itself. It said that it had gotten photographed in the past and then not found them particularly helpful in trying to determine whether or not there had been missing tiles on previous flights.

And so, they felt that they would not be particularly helpful in this case.

So they've explained why they chose not to do that. And it will be up to Admiral Gayman and his team to decide whether or not that was a good management choice.

NELSON:

So you don't have an personal opinion about that?

SMITH:

No, sir.

NELSON:

Go ahead, Mr. Chairman. I've got several other questions, but...

BROWNBACK:

I've had my chance. I was just getting ready to close the panel down when you came in.

NELSON:

Do you have another panel coming?

BROWNBACK:

No, this is the - this is it. So if you have another couple questions, go ahead and ask them, and then we'll finish up.

NELSON:

Now I have more than a couple.

BROWNBACK:

All right. We may bounce with a little bit here. I may give you the gavel and go on. Go ahead.

NELSON:

I'd love that, Mr. Chairman.

Last time I had the gavel in the subcommittee, we went for five hours.

BROWNBACK:

Well, I couldn't handle that.

NELSON:

As we look at some of the things that are happening, do you have any technical suggestions for this committee about buying some more time if you've got a damaged area of an orbiter, and you want to buy some more time, does it -- I'm not suggesting there was anything that could be done to save this particular mission, such as cold soaking or higher angle of attack or keeping, if your damaged area is your left wing, keeping your left wing up instead of the role reversal taking it back into the left wing down?

Any suggestions?

ROLAND:

Senator, I don't have the technical competence to answer that specifically. But I do have a suggestion that I think's in the same realm. I think in the future, until we either have a clearer idea and clearer prospects of a new and safer shuttle, that all shuttle missions in the future should go to the space station and should involve an inspection of the shuttle before it returns.

And additionally, we might want to consider -- we've been speaking earlier about developing a small astronaut orbiter, which would be only to transport people to and from orbit. And then we might want to consider using the shuttle unmanned as a heavy lift vehicle. And it can fly up, and it can fly back without the astronauts on board. And it's a way -- it doesn't hold down the cost, but it surely holds

down the risk to human life of a technology that I think is becoming more fragile as time goes on.

NELSON:

Any other comments?

CHASE:

No, I don't have the technical background or the currency with the programs to make the recommendations.

NELSON:

The future of human space flight, where in your opinions, would you like to see us go as we get back into flying with the space shuttle?

What would you like to see the program evolve into?

(UNKNOWN)

Senator, one of the discussions that we've been having is this notion of a destination driven program versus building capabilities that let us go multiple destinations. And I think that's a very good debate to have. I'm not sure that there's -- that debate has been decided, but clearly NASA is moving towards this notion of building capabilities to do a number of things.

Rather than simply building a vehicle that goes to Mars, or just goes to the moon, why not build capabilities that let us do a number of things in space? They could be applied to robotic missions, to human missions, and anything else that we might want to do.

One of the recommendations put forward in the commission on the future of the aerospace industry, chaired by Congressman Robert Walker, was just that notion that you need to develop the capabilities to do a number of missions. And in a lot of ways, that's more exciting to understand that you have the capability to

developing nuclear propulsion and power options for in space transportation, that you can then take that and apply it to a number of missions to send the robotic probe to Europa, to send a human mission to Mars.

That, I think, opens up your possibilities. You have some challenges in perhaps how you motivate that team that develops the systems, because they may not know exactly what they're driving towards. But it does open up your possibilities.

And that's where I think we should go. The most important element in all that is the access to space. Getting low cost access to space is critical. The capabilities of the shuttle are critical for the short and near term. Then as you develop and phase in the next generation systems, that's what enables you to drop the costs.

And I was encouraged by your comments earlier and your comments in the past related to the role the Department of Defense can play in future space access, both in developing next generation ROVs, and perhaps how the fleet of evolved expendable launch vehicles, EELVS, can play in our space transportation needs.

Those are very robust and very new systems that are much simpler, much more efficient than their predecessors. I think there's a major role for them to play in future access.

SMITH:

Well, senator, I'm not allowed to take positions to have opinions. So about all I can offer in this context is that it's...

NELSON:

But you're one of the great experts on space.

SMITH:

But it may be useful to have the context set for where it is that NASA and America expect to go in the long term in human exploration. Most of NASA's programs have this long term view. And as the planetary program does, the astronomy program does. But when you get to human space flight, the space station is basically it.

Because it's taken so many more years and people expected for it to become operational, still not there yet. People have sort of given up looking at what is beyond space station. In fact, NASA I don't think even has a cut-off for when the space station is going to stop operations to transition to something else. And so, in terms of trying to develop an architecture for the future, and decide what your options are, and what kind of launch vehicles you need, and whether you want to have one vehicle for human space flight, and another vehicle for cargo, you really need to know where it is down the road all of this is going to be taking you.

And I know that there are a few people at NASA who have been looking at this over the past few years, but because of the funding situation at NASA, I think there aren't a lot of people there who feel that they can stand up and say, you know, yeah, this is the way it's going to be.

And so I think that, you know, even after all these years and after all the studies that have been done on future space goals, that here we are in 2003, and it's still not clear what direction this is all leading in. And I think that's an important component of then backtracking and say so what kind of launch vehicles do I need?

ROLAND:

I don't think -- with our current technology there are any missions for people in space that are worth the cost and the risk. But that does not mean that there's not a value for human missions in space, conceivably on a space station, conceivably going to the moon, going to Mars.

And the question is, when will the cost come down enough, that that value of having people there, which is now so much more expensive, intersect with that cost? And I think that the space program should be focused on making that happen sooner, rather than later.

And that means launch vehicle development. I think Mr. Chase and I agree that access to space is the big issue. And that's where we should be concentrating our research and development.

NELSON:

Mr. Chairman, I'll conclude my comments just by responding to Dr. Roland in one sense, I agree with you. And that is that the risk for human space flight are not accurately projected.

Indeed, in a flight that I participated in 17 years ago, at the time it was generally thought to be catastrophic, one in 100. It ended up being one in 25.

And now we know it's two in 113. And that's why I have been unrelenting in my advocacy for the safety upgrades on the space shuttle and have been unforgiving, Mr. Chairman, to a NASA that has not pressed with those safety upgrades as a first priority of business.

Instead, stealing money from the space shuttle, which would have gone into safety upgrades, and other things, and putting it in other things in this. So in that regard, I think you're right.

Where I would disagree with you, and this is my concluding comment, Mr. Chairman, because I know you want to shut down, and that is that Americans are by nature explorers. We're about to celebrate the 200th anniversary of Lewis and Clark. And that was a big deal in the day. That was like an Apollo project in their day. And that reaped enormous benefits for us.

And I think that we need as a country not only the development of the technologies and all of those spinoffs to the value of our society here on the planet, but fulfilling that part of our nature as explorers.

For example, one of my crew mates, Dr. Franklin Chang Diaz, has been developing over the last 30 years a plasma rocket that he's just about ready to test, if NASA will keep giving him the money. He's got a 30 university consortium. He's got a test model. And this thing would ultimately take us to Mars in 39 days instead of 10 months, which is conventional technology, would solve the problem of gravity because it would accelerate half the way and deaccelerate the remaining half way, and would create a magnetic field around the rocket, which would help us repel the solar flares.

And so, these are the kind of things that I think we've got to be visionary. And I'm so grateful to you, Mr. Chairman, because you are a visionary. And I'm glad you're the chairman of this committee.

BROWNBACK:

Thank you very much. Thank you very much, Senator Nelson, Astronaut Nelson. I want to thank the panelists as well. This is a -- the start of a lengthy process. It's been going on for some period of time. But we do want to fulfill the dreams of us as explorers. And I don't think anybody on the panel disagrees with that. It's just how we do that and how we proceed forward.

I want to thank all of you individually for your expertise and your continued support and enthusiasm for how America proceeds forward to -- into space.

Thank you very much. Hearing's adjourned.

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